LNE-SYRTE clock ensemble: Developments and Applications in metrology and fundamental physics.

S. Bize, LNE-SYRTE, 61 avenue de l'Observatoire, 75014 Paris, France.

We will give an overview of recent developments of LNE-SYRTE atomic clock ensemble.

In the microwave domain, LNE-SYRTE is operating 3 atomic fountains (FO1, FO2, FOM) driven by an ultra stable cryogenic sapphire resonator oscillator (CSO). One of these fountains (FO2) is designed to operate both with caesium and rubidium. We will review several methods that have been developed to improve these atomic fountains. This includes methods for optimally using the CSO leading to fractional frequency instability of 1.6×10^{-14} at one second. Methods for better controlling the cold collision shift in Cs fountain has been developed as well as other original methods to deal with other systematic shifts. New Stark shift measurements and other measurements related to the black body radiation shift have been performed. With these methods, all three fountains have accuracy near 5×10^{-16}. Over the past few years, extensive comparisons between these atomic fountains have been performed with typical resolution of 10^{-16}, the most stringent comparison between primary frequency standards to date. This fountain ensemble has been used for a wide range of applications such as absolute measurements of the rubidium hyperfine splitting and the subsequent definition of secondary representation of the SI second, repeated calibration of the international atomic time TAI, test of the stability of fundamental constants, test of the isotropy of space, absolute frequency measurement of optical frequency standards, test of subsystems to support the development the PHARAO cold atom space clock.

LNE-SYRTE is also developing optical lattice clocks based on Sr and Hg. Here, we will focus on the development of the neutral mercury optical lattice clock and report the current status of this recently started project.